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# COMPARATIVE STUDY OF THE SOFT PALATE.

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BY WILLIAM FAIRFIELD MERCER, PH. M.

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WITH PLATES I AND II.

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In the preparation for the observations given below sections were made of the soft palate of the cat, adult and fetal, the rat, the guinea-pig, the calf, and the puppy.

Most of the hardening was done in picric alcohol, sections cut in paraffin,  $10\mu$  thick, stained in hematoxylin, and counter-stained in picro-fuchsin.

In general the same tissues are found in all the palates studied, but with quite a range of distribution, no two of them having the same relative amount or position of the parts.

A section of the palate of the puppy is represented in Figure 1. The epithelium of this palate, as of all of them, is of two kinds, squamous and columnar, and extends over the entire surface of the organ. The squamous epithelium is of the typical form and extends over the entire oral surface, around the free end, upon the nasal surface to a point marked *x*, Figure 1, where it is gradually replaced, in a manner to be described later, by the columnar epithelium which extends over the remaining surface of the organ.

Under the epithelium, closely connected with it, is a layer of connective tissue. This extends quite generally throughout the organ and surrounds masses of glands. These glands are of the typical mucous form (Fig. 8). In the puppy, which is the one now under consideration, these glands open upon both surfaces by the means of ducts (Fig. 1, *Gd*). The glands in this particular palate are arranged upon the two sides of a central mass of striated muscle (Fig. 1, *M*) which extends the

entire length. It seems to be the general rule for the glands to be arranged so that the opening is to the side opposite a band of muscles. If the muscle is through the middle they open upon both surfaces, if at one side the ducts extend to the opposite surface.

Blood vessels, nerves, and lymphoid tissue are quite generally distributed throughout the organ.

A section of the soft palate of the rat is represented in Figure 2. In this the squamous epithelium extends farther if anything upon the nasal surface as at *x*, Figure 2. The connective tissue is arranged similarly to that in the palate of the puppy, but the layer of muscles (*M*) is entirely at the nasal side and the glands are all at the oral side of the palate, and therefore open into the mouth and not into the nasal cavity. As seen in the figure the glands are in a continuous mass. In this palate the muscles have more of a varied direction, for there are some trans-sections of muscle as well as longi-sections in the same specimen. Blood vessels are quite prominent.

Figure 3 represents a longi-section of the palate of the guinea-pig. The first thing that attracts one's attention to the palate of the guinea-pig is the way it is arranged in the throat of the animal. The palate extends in a continuous curtain backward and downward and joins with the tongue at the sides, so the only opening into the pharynx is a small hole in the middle line, not larger than a fair sized lead pencil. In cutting through the center, the appearance in Figure 3 is given. A section of a piece of the tongue (*T*) is shown in relative position.

In this palate the ciliated epithelium (*Ce*) extends to the point *x* on the nasal surface.

The connective tissue is about equally distributed upon both sides of the glandular tissue (*Mg*) which is not found, or very little at most, near the free end of the palate. This free end has, in the place of the glandular tissue, more muscles. In this, as in the palate of the rat, the glands are all at the one side of the layer of muscle and their ducts (*Gd*) invariably open

upon the oral surface. Lymphoid tissue (*L*) is rather more abundant than in the rat and less so than in the puppy.

The section of the palate of the calf (Fig. 4) shows a massive organ, but with quite general characteristics as compared with those of the puppy; having epithelium of the same kind and extent, and muscles extending through the center with the glands (*Mg*) upon either side sending their ducts (*Gd*) to both surfaces.

The direction of the muscles differs greatly from that of the puppy. In this, the sections being cut in the same general plane, the muscles are cut in various directions, while in the puppy they are cut in perfect longi-section. The distribution of gland substance is somewhat different from any of the palates described, viz., that small masses are found distributed at varying intervals throughout the connective tissue (*C*) as well as large masses bordering upon the muscles.

Figure 5 represents a longi-section of the palate of the adult cat. In this the shape first attracts attention, being thick at the fixed end while comparatively thin at the free margin. The thickened portion contains large masses of glandular tissue while the thinner portion contains very little. The glandular tissue has quite a well marked division, indicated by *C*<sup>1</sup>, which throws it into two groups. The ducts (*Gd*) from these divisions open upon their respective surfaces. So in the cat, ducts open upon both the nasal and oral surfaces. In the free end of the palate is found a mass of glandular tissue mixed with lymphoid tissue. Ciliated epithelium extends down the nasal surface to *x*. The muscles appear in longi-section in the free end, in the thickened portion in cross or oblique sections.

Figure 6 shows a section of the palate of the rabbit. In this, while the epithelium and connective tissue are about as in the others in extent and quantity, the glands are in great excess, extending throughout the organ to the very tip. The muscles are all bunched at the nasal side, thereby throwing the glands to the other (the oral) with all their openings upon that surface. In the section described the muscles are cut in various direc-

tions. In the thicker portion of the section there is found a band of connective tissue ( $C^1$ ) which is quite characteristic of this palate. This separates the glands from the muscles. Lymphoid tissue ( $L$ ) is more abundant in this palate than in any other described.

Figure 8 shows a section of the mucous gland with a duct. The characteristic mucous cell ( $mg$ ) is found. The cells extend to the lumen of an acinus,  $A^1$  in cross section and  $A$  in longi-section, with the nucleus at the outer margin. Blood vessels are distributed throughout the tissue, held in place by fibers of connective tissue. The gland duct ( $Gd$ ) is made up of a coat of connective tissue lined by a layer of epithelial cells (Fig. 9,  $E$ ) which is continuous with the epithelium of the surface. Figure 9 shows the portion of Figure 8 indicated by the arrow, under the 1-12 oil immersion lens.

Figure 7 represents a section of the palate of the fetal kitten. This has no glands as such; but in their place a mass of cells with large nuclei. In some places the razor has passed through these cells in the plane of the long axis of the mass. In these sometimes a lumen is noticed but no mucous cells, as are found in the adult, or even in the new born kitten. By tracing a mass of these cells through a series of sections the cells are found to be continuous with the epithelium of the surface and of the same kind. In this the ciliated epithelium extends around the free end of the palate from the nasal surface to the oral surface, to a point  $x$  quite a distance from the apex. It is evident that these cells are ciliated until the organ is put to use, when the ciliated epithelium is replaced by squamous epithelium.

In the place of connective tissue and muscle as such, the structure is more a mixture of both, connective tissue fibers with elongated nuclei between them, with now and then a few muscle fibers, not very distinct.

Of the soft palates studied three had ducts opening upon both surfaces, that of the cat, the puppy, and the calf. Three had ducts opening upon one surface only, viz., the guinea-pig, the rabbit, and the rat. Invariably, if the ducts open upon one

surface only it is upon the oral. So the nasal surface must receive its mucous from other sources than itself. The relative arrangement of the other tissues of the organ is determined by the location of the glands with respect to the muscles.

This investigation also brings out the fact that the cells of the columnar epithelium extend to the basement membrane instead of being stratified as formerly described. Cells of varying form, from round to quite elongated, are found among the long tapering portions of the ciliated cell (Fig. 10, *Ce*). This figure is taken at the point of transition of the two forms of epithelium. It is to be noticed that at the point of transition between the ciliated and the squamous epithelium the cells of the squamous epithelium (*Se*) are overlaid with the cells of the columnar epithelium, that the cells of the columnar epithelium become shorter, and the cilia less and shorter as they push out over the squamous epithelium. The bases of the cells rest upon the layer of connective tissue (*C*) described in other parts of the paper.

*Cornell University, Department of Histology and Embryology.*

## PLATE I.

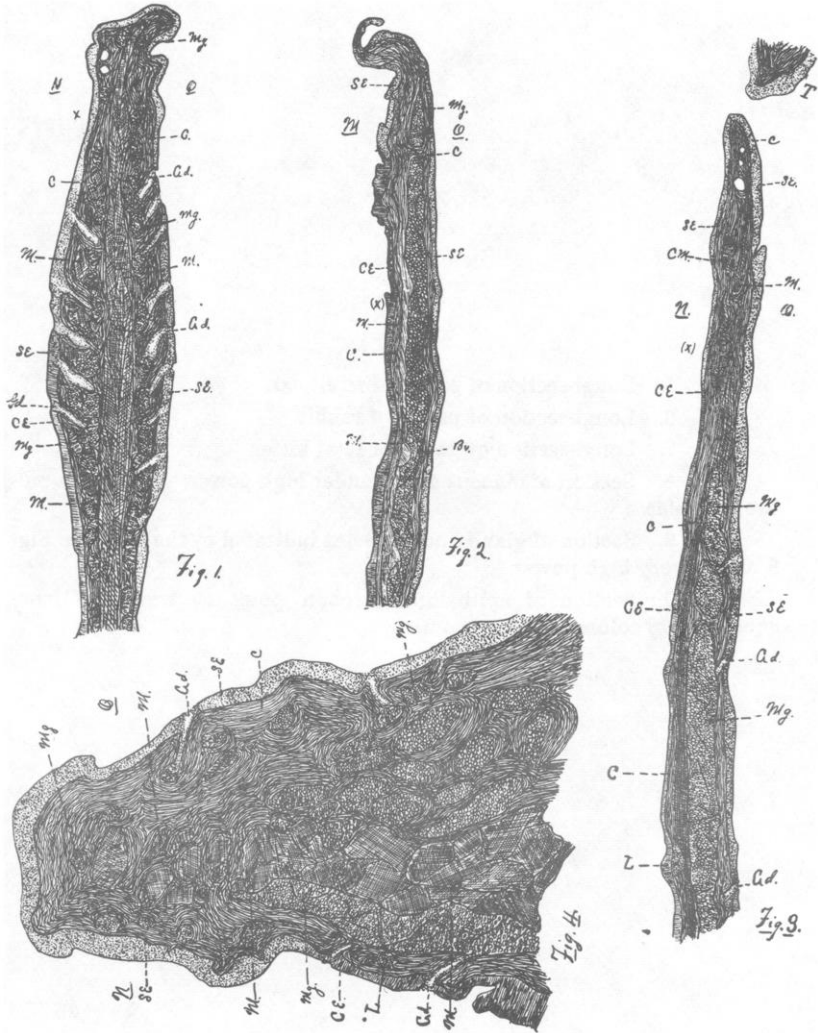
- Fig. 1. Longi-section of palate of puppy.  
Fig. 2. Longi-section of palate of rat.  
Fig. 3. Longi-section of palate of guinea-pig.  
Fig. 4. Longi-section of palate of calf.

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List of Abbreviations used in Figures.

- A.* Lumen of acinus, longi-section.  
*A<sup>1</sup>.* Lumen of acinus, cross section.  
*Bv.* Blood vessel.  
*C.* Connective tissue.  
*C<sup>1</sup>.* Connective tissue between muscle and glands.  
*Ce.* Columnar epithelium.  
*E.* Epithelium lining gland ducts.  
*Gd.* Section of gland duct.  
*L.* Lymphoid tissue.  
*Lm.* Lymphoid tissue with glandular tissue.  
*M.* Muscle, striated.  
*Mg.* Mucous glands.  
*N.* Nasal side.  
*O.* Oral side.  
*Se.* Squamous epithelium.  
*x.* Point of division between squamous and columnar epithelium.

# PLATE I





**PLATE II.**

Fig. 5. Longi-section of palate of adult cat.

Fig. 6. Longi-section of palate of rabbit.

Fig. 7. Longi-section of palate of fetal kitten.

Fig. 8. Section of mucous gland under high power, taken from palate of rabbit.

Fig. 9. Section of gland duct, at point indicated by the arrow in Fig. 8, under very high power.

Fig. 10. Section of epithelium through point of transition from squamous to columnar epithelium.

# PLATE II

